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(54) IMPROVEMENTS RELATING TO OPTICAL VIEWING APPARATUS

(71) We, BRITISH AIRCRAFT CORPORATION LIMITED, a British Company, of 100 Pall Mall, London, S.W.1., do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to optical viewing apparatus.

When tracking missiles of the kind which generate a flare a problem is encountered in twilight or other semi-dark conditions when the flare of the missile tends to dazzle the viewer or, where an image intensifier is used, overload the image intensifier. It is an object of the present invention to provide a viewing system in which dazzle or overloading due to a bright image, for example that of a missile flare, is at least reduced.

According to the present invention optical viewing apparatus includes, in combination, converging lens means, a liquid crystal cell positioned in the focal plane of the lens means so that a real image of a distant scene to be viewed may be formed thereon, the cell being of the kind having electrodes comprising two series of parallel transparent conductive members, the two series being set orthogonally with respect to each other and located on opposite sides of the liquid crystal layer, viewing means for viewing the cell, and photosensitive positional detection means arranged to vary the electric field between appropriately intersecting conductive members in response to light incident upon the positional detection means from a bright object in the scene, whereby to at least partially reduce the intensity of the image of the bright object as seen by the viewing means.

For a better understanding of the invention two preferred embodiments will be described with reference to the accompanying drawings in which:—

Figure 1 shows diagrammatically one embodiment of the viewing apparatus including a light transmitting liquid crystal cell, and

Figure 2 shows diagrammatically another embodiment of the viewing apparatus including a light scattering liquid crystal cell.

Referring now to Figure 1, the viewing apparatus includes a convex objective lens 1, a liquid crystal cell shown generally at 2 of the type having a variable transmission factor, the cell being positioned in the focal plane of the objective lens 1 so that a real image of a distant scene may be focused thereon. A viewing lens 3 is positioned for viewing the plane of the cell 2, and a beam-splitter 4 is positioned between the objective lens 1 and the cell 2 to divert a portion of the image forming light to form a similar image on a position sensitive photodetector 5.

The liquid crystal cell 2 is of the type exhibiting a dye-phase change effect. In this type of cell a liquid crystal is doped with a dye, which absorbs light only when all the molecules are orientated in one direction. The orientation of the dye molecules is affected by the orientation of the liquid crystal molecules, the orientation of which is in turn affected by an electric field. The liquid crystal cell 2 comprises a liquid crystal layer 2*a* between two glass plates 2*b*. Each glass plate is provided on its inner surface with a series of parallel transparent conductive strips 2*c* 2*d*, each series being set orthogonally with respect to each other.

The position sensitive photodetector 5 comprises a planar array of photo-diodes, the position of each photo-diode corresponding to the position of an intersection of two of the mutually orthogonal conducting strips in the cell. When light from a bright object is incident upon a photo-diode the photo-diode will produce an X and Y signal corresponding to its position in the array and this signal is supplied via banks of connections 6, 7 to the appropriate conducting strip in the series 2*c* and 2*d* respectively.

In operation, an image of the scene being viewed is formed on both the liquid crystal layer 2*a* which is arranged to transmit light incident upon it, and on the photo-detector 5. The X and Y signals produced by the photo-

detector in response to light from a bright object, due for example to a missile flare, bias the appropriate strips in the series 2*c* and 2*d*. The electric field thus produced at the appropriate intersections will be of sufficient strength to trigger local changes in the transmission factor of the cell. The liquid crystal layer then absorbs light incident in that region thus reducing the intensity of light transmitted through that region and so causing corresponding local reduction of intensity of the light received by the viewing lens 3.

Referring now to Figure 2 where like parts to those of Figure 1 are given like references, the liquid crystal is of the type exhibiting optical scattering. A liquid crystal cell operating in the scattering mode scatters light strongly in all directions but some transmission occurs. When a voltage applied across the liquid crystal layer produces an electric field of sufficient strength the liquid crystal layer 2*a* becomes transmitting.

With the cell 2 arranged to scatter light it acts as a screen onto which a real image of the scene to be viewed is focused. Back-scattered light from the cell 2 is collected by a lens 8 and focused into an image intensifier 9 producing a generally enhanced image which may be seen by an observer through the viewing lens 3. Transmitted light is collected by a lens 10 and focused onto the photo-detector 5 to form a secondary image similar to that formed on the cell.

When light from a bright object forms part of the secondary image, X and Y signals corresponding to the positions of the high intensity light are produced by the photodiodes receiving such light. These signals are supplied via banks of connections 6, 7 to the appropriate conductive strips of the series 2*c* and 2*d*. The signals produce a local electric field across the liquid crystal layer 2*a* at points of intersection of the strips, causing that region of the cell to become non-scattering. The image on the cell 2 as seen by the observer then contains a dark area at positions corresponding to the high intensity positions. The photo-detector 5 array of photo-diodes may be conveniently formed on the rear surface of the liquid crystal cell 2 obviating the need for the lens 10 to form the secondary image since dispersion of forward scattered light over the thickness of the cell is negligible.

In the embodiment shown in Figure 1 the liquid crystal cell exhibiting a dye phase change effect could be replaced by a liquid crystal cell operating in a scattering mode but with the electric field applied in an inverse sense, that is, the cell is arranged to transmit light below the threshold intensity but to scatter light in regions of high intensity.

A liquid crystal cell operating in the twisted nematic mode could also be used in the embodiment shown in Figure 1 in place of the cell exhibiting a dye phase change. The cell is provided with a polariser and an analyser and is arranged to transmit light. When a voltage is applied across the liquid crystal layer 2*a* the direction of polarisation is rotated so that the cell becomes opaque.

WHAT WE CLAIM IS:—

1. Optical viewing apparatus including, in combination, converging lens means, a liquid crystal cell positioned in the focal plane of the lens means so that a real image of a distant scene to be viewed may be formed thereon, the cell being of the kind having electrodes comprising two series of parallel transparent conductive members, the two series being set orthogonally with respect to each other and located on opposite sides of the liquid crystal layer, viewing means for viewing the cell, and photosensitive positional detection means arranged to vary the electric field between appropriately intersecting conductive members in response to light incident upon the positional detection means from a bright object in the scene, whereby to at least partially reduce the intensity of the image of the bright object as seen by the viewing means.

2. Optical viewing apparatus according to claim 1 including a beam splitter positioned between the converging lens means and the liquid crystal cell and arranged to direct an image of the viewed scene onto the positional detection means.

3. Optical viewing apparatus according to claim 1 wherein the positional detection means is positioned behind the cell so as to respond to light transmitted through the cell.

4. Optical viewing apparatus according to any preceding claim wherein the positional detection means comprises a planar array of photodiodes each of which corresponds to an intersection of two of the mutually orthogonal conductive members.

5. Optical viewing apparatus according to claim 1 or claim 2 wherein the viewing means is arranged to receive light transmitted by the cell.

6. Optical viewing apparatus according to claim 1 or claim 3 wherein the viewing means is positioned on the incident light side of the cell.

7. Optical viewing apparatus substantially as described herein with reference to Figure 1 of the accompanying drawings.

8. Optical viewing apparatus substantially as described herein with reference to Figure 2 of the accompanying drawings.

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COMPLETE SPECIFICATION
This drawing is a reproduction of the Original on a reduced scale.

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Fig.1.

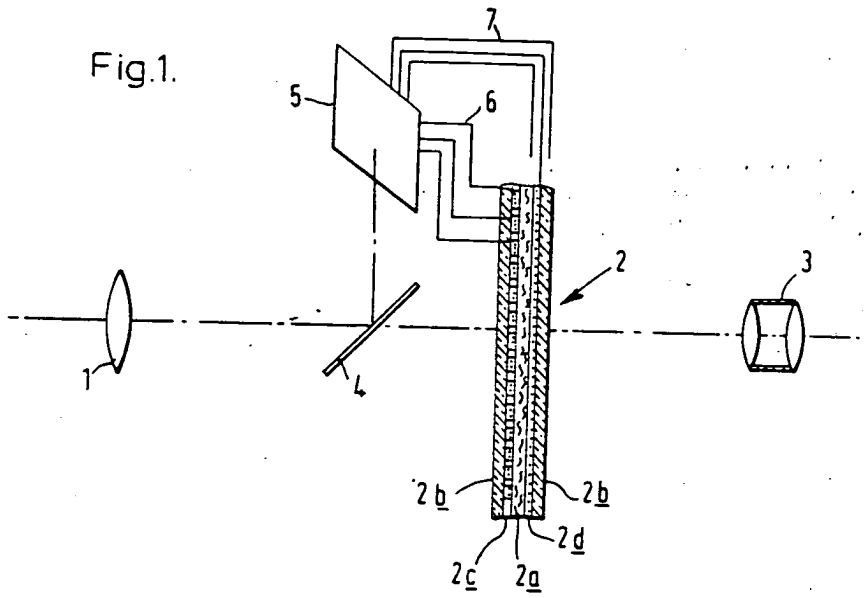

Fig.2.